

48. The epitaxial growth method of III-V nitrides of claim 34 further comprising annealing at a temperature of 700°C or more.

49. The epitaxial growth method of III-V nitrides of claim 48 wherein the annealing occurs after the coating and before the growing.

50. The epitaxial growth method of III-V nitrides of claim 49 wherein the annealing occurs in a gas atmosphere, wherein the gas atmosphere comprises a gas, wherein the gas comprises oxygen as an element.

51. The epitaxial growth method of III-V nitrides of claim 48 wherein the annealing occurs in a gas atmosphere, wherein the gas atmosphere comprises a gas, wherein the gas comprises oxygen as an element.--

## REMARKS

### I. CLAIM OBJECTIONS

Claim 33 stands objected as being dependent on a non-elected claim. It is respectfully submitted that in view of the remarks below, independent claims 16 and 34 are patentable over the cited prior art. Accordingly, it is believed that all non-elected claims will be rejoined and allowed so that no amendment to change dependency of claim 33 is necessary at this time.

**II. CLAIMS 34-43 ARE ENABLED**

Claims 34-43 stand rejected under 35 U.S.C. § 112, first paragraph (enablement). Claim 34 has been amended to correct an inadvertent grammatical error. It is submitted that claim 34, as amended, is fully enabled by the original specification. Based on the foregoing, it is respectfully requested that the rejection (and objection) of claims 34-43 under § 112, first paragraph, be withdrawn.

**III. CLAIMS 25 AND 43 ARE ENABLED**

Claims 25 and 43 stand rejected under 35 U.S.C. § 112, first paragraph (enablement). This rejection is respectfully traversed for the following reasons. The Examiner alleges that the limitation of "an alloy film is grown by sequential combination of more than two growth methods" is not supported in the original specification. However, it is submitted that many portions of the specification support such a limitation. For example, the Examiner is directed to page 7, lines 8-10, which states in pertinent part, "[t]he overgrown GaN layer 340 ... can be grown by ... any sequential combination of the above three growth methods" (emphasis added). Such disclosure supports a process by which two or three of the disclosed growth methods (i.e., MOCVD, molecular beam epitaxy, and hydride vapor phase epitaxy) are used in a desired sequential combination.

Based on the foregoing, it is respectfully requested that the rejection of claims 25 and 43 under 35 U.S.C. § 112, first paragraph, be withdrawn.

**IV. CLAIM 16 IS DEFINITE**

Claim 16 stands rejected under 35 U.S.C. § 112, second paragraph. This rejection is respectfully traversed for the following reasons. It is not understood why the generic term "certain" is indefinite. Nonetheless, in order to expedite prosecution, claim 16 has been amended to replace "certain" with another generic term --selected--, which is submitted to be clear and definite. Based on the foregoing, it is respectfully requested that the rejection of claim 16 under 35 U.S.C. § 112, second paragraph, be withdrawn.

**V. REJECTIONS UNDER 35 U.S.C. § 103****A. CLAIM 16**

Claim 16 stands rejected under 35 U.S.C. § 103 over Hanaoka et al. ('839), Nishio et al. ('606), or Furushima ('520), in view of Agostinelli et al. ('103). These rejections are respectfully traversed for the following reasons.

It is respectfully submitted that at best, the Examiner has attempted to show only that the elements (i.e., spin coating and a III-V nitrides alloy) of the claimed invention are *individually* known without providing a *prima facie* showing of obviousness that the *combination* of elements recited in the claims is known or suggested in the art. The Examiner relies on Hanaoka et al. ('839), Nishio et al. ('606), or Furushima ('520) as allegedly disclosing a general epitaxial growth method of a III-V nitride alloy; whereby a buffer layer and a nitrides alloy film are placed on a substrate. However, as admitted by the Examiner, none of the aforementioned references disclose or suggest using spin-coating as the process by which the buffer layer is placed on the substrate. Assuming *arguendo* that the Examiner's allegations regarding the disclosures of Hanaoka et al.

('839), Nishio et al. ('606), or Furushima ('520) are accurate, it is submitted that they are merely cumulative to Applicant's admitted prior art shown in Figures 1A-1C of Applicant's specification.

In order to read the prior art on the claimed invention, the Examiner attempts to modify Hanaoka et al. ('839), Nishio et al. ('606), or Furushima ('520) with the teachings of Agostinelli et al., which discloses a spin-coating process for applying a III-V compound to a substrate. However, Agostinelli et al. is not directed to a *nitrides alloy film* which is placed *on* the spin-coated film. Accordingly, it is submitted that none of the cited prior art discloses or suggests the *combination* of forming a nitrides alloy film on a *spin-coated* buffer layer.

Claim 16 recites in pertinent part, "growing an III-V nitrides alloy film on the *spin-coated* film." As described in the Background of the Invention at page 2, lines 12+ of the specification, "nitride growth is very difficult because there is no GaN substrate available [so that] nitrides have to be grown on lattice-mismatched substrates ...[resulting in] the grown GaN [containing] a lot of dislocations or crystal defects which affect the device performance. The crystal defects usually appear with very rough surfaces suggesting three dimensional growth which is related to the misaligned initial growth layer." As such, the prior art is subject to non-uniform, crystal defect/dislocation laden structures.

Accordingly, there is a need in the art for growing uniform nitride layers on large diameter substrates, whereby the formed nitride layers have crystal structures whose defects/dislocations can be reduced. The present invention has been designed to solve at least the aforementioned problems by forming the nitrides layer on a *spin-coated* buffer

layer. Whereas Hanaoka et al. ('839), Nishio et al. ('606), and Furushima ('520), similarly to the admitted prior art shown in Figures 1a-1c of Applicants' specification and as admitted by the Examiner, all use MOCVD to deposit the buffer layer. In fact, the prior art *prefers* MOCVD over other available techniques (*see, e.g.*, Nishio et al., col. 4, line 50), thereby *teaching away* from using spin-coating, so as to increase efficiency by using a single processing chamber for the manufacturing process. None of the cited prior art considers or recognizes any disadvantage of using MOCVD for manufacturing the buffer layer, nor the advantages/benefits for using spin-coating for forming *specifically a buffer layer on which a nitrides alloy film is grown*.

Turning to Agostinelli et al., the disclosure relied on by the Examiner identifies only that spin-coating is a known technique (not disputed herein). However, the spin-coated layer of Agostinelli et al. is NOT a buffer layer, but rather, can be used as a final product so that no further layer is added thereon. In contrast, the spin-coated layer of the present invention can function as a buffer layer between a substrate and a nitrides film grown thereon so as to reduce crystal cracks/dislocations relative to the conventional method using a MOCVD method to form a buffer/nitrides laminate. Accordingly, there is no suggestion in the prior art for using a spin-coated layer, rather than an MOCVD layer as in the prior art, as a buffer layer on which a nitrides layer is grown. Instead, Agostinelli et al. merely shows that spin-coating is a known technique *generally*, but Agostinelli et al. does not suggest using spin-coating *specifically* when used to form a buffer layer that has a nitrides layer formed thereon.

Applicants are not claiming novelty to spin-coating *per se*, but rather, the use of spin-coating to form a buffer layer on which a nitrides layer is grown. Only Applicant

has conceived of using spin-coating for a buffer layer so as to help reduce crystal defects/dislocations in a nitrides alloy film, which are problems associated with such epitaxial growth nitride laminates. The cited prior art does not recognize nor consider such non-uniformity problems in large diameter nitride semiconductors. The cited prior art, at best, suggests only using MOCVD for a buffer layer, or using spin-coating as a general technique for forming a top layer on a substrate (i.e., not for forming a buffer layer having crystal non-uniformity to layers formed thereon).

It is therefore submitted that the proposed combination is improper because the Examiner has not provided the requisite *objective* evidence *from the prior art* that "suggests the desirability" of the proposed combination. The Examiner alleges, as motivation for replacing the MOCVD method with spin-coating for forming a buffer layer, that such a modification would "lower processing temperatures ... which reduces operating costs." The Examiner relies on col. 3, lines 35-65 of Agostinelli et al. as support for this position. However, this portion of Agostinelli et al. does NOT attribute any of the purported advantages of the device of Agostinelli et al. to using spin-coating. In fact, this portion of Agostinelli et al. is completely silent as to any motivation or rationale for using spin-coating, let alone using spin-coating specifically for a buffer layer in a nitrides alloy. Accordingly, the prior art does not provide any motivation or rationale for replacing the conventional MOCVD method for forming *buffer layers* with the spin-coating method of the present invention. As such, it is respectfully submitted that the Examiner's asserted motivation for making the proposed combination is based solely on improper hindsight reasoning, whereby the Examiner selected bits and pieces of the prior

art and used only Applicants' specification as a guide to reconstruct the claimed invention.

As is well known in patent law, a *prima facie* showing of obviousness can only be established if the prior art "suggests the desirability" of the proposed combination using *objective* evidence. The Examiner is directed to MPEP § 2143.01 under the subsection entitled "Fact that References Can Be Combined or Modified is Not Sufficient to Establish *Prima Facie* Obviousness", which sets forth the applicable standard:

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. (*In re Mills*, 16 USPQ2d 1430 (Fed. Cir. 1990)).

In the instant case, even assuming *arguendo* that Hanaoka et al. ('839), Nishio et al. ('606), and Furushima ('520) can be modified by Agostinelli et al., it is submitted that the "mere fact that the references can be combined ... does not render the resultant combination obvious" because nowhere does the *prior art* "suggest the desirability of the combination" as set forth by the Examiner. That is, the cited prior art does not suggest the desirability of growing a nitrides film on a *spin-coated* film rather than a MOCVD film. In fact, the prior art actually desires using MOCVD for the buffer layer as evidenced by col. 4, line 50 of Nishio et al. for the purpose of reducing cost by using a single processing chamber to form the layer.

The Examiner is further directed to MPEP § 2143.01 under the subsection entitled "Fact that the Claimed Invention is Within the Capabilities of One of Ordinary Skill in the Art is Not Sufficient by Itself to Establish *Prima Facie* Obviousness", which sets forth the applicable standard:

A statement that modifications of the prior art to meet the claimed invention would have been [obvious] because the references relied upon teach that all aspects of the claimed invention were *individually* known in the art is *not* sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. (citing *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993)).

In the instant case, even assuming *arguendo* that the references "teach that all aspects of the claimed invention [are] individually known in the art", it is submitted that such a conclusion "is not sufficient to establish a *prima facie* case of obviousness" because there is no *objective* reason on the record to combine the teachings of the cited prior art in the manner set forth by the Examiner. In contrast, the cited prior art is completely silent as to suggesting the *combination* of growing a nitrides film on a *spin-coated* layer. As is well known, patentable subject matter typically arises from using *known* elements/processes in novel *combinations*. In the instant case, it is respectfully submitted that the Examiner is alleging III-V nitrides alloy and spin-coating are well-known *separately*, whereas it is respectfully submitted that such an allegation, even if true, is not sufficient to render obvious the *combination* of using spin-coating as the method by which a buffer layer is formed (on which the nitrides alloy film is grown).

For all the foregoing reasons, it is submitted that the proposed combinations are improper, and that claim 1 and its dependent claims are patentable over the cited prior art.

#### **B. CLAIM 34**

Claim 34 stands rejected under 35 U.S.C. § 103 over Furushima ('520) in view of Ito et al. ('035). This rejection is respectfully traversed for the following reasons.

For the same reasons discussed above with respect to claim 16, it is submitted that the proposed combination is improper because neither Furushima nor Ito et al., alone or

in combination, suggest using spin-coating as the method by which a buffer layer on which a nitrides alloy film is grown. Similarly to Agostinelli et al., Ito et al. merely discloses that spin-coating is known for forming a zinc oxide layer 18 for a varistor. Accordingly, Ito et al. does not suggest forming a spin-coated buffer layer on which a III-V nitrides layer is formed (i.e., zinc oxide layer is sandwiched between two electrodes as part of a varistor). Ito et al. is not related to the problems associated with epitaxial growth III-V alloys and does not provide any motivation for using spin-coating, rather than MOCVD, in the alleged III-V device of Furushima.

Again, similarly to manner used in Agostinelli et al., the Examiner relies on col. 2, lines 25-55 of Ito et al. as the motivation for replacing the conventional MOCVD method with spin-coating. However, the relied on portion of Ito et al. does NOT attribute any of the purported benefits of Ito's disclosure (which is directed to varistors) to spin-coating rendering the proposed combination without a proper motivation/rationale from the prior art (i.e., only Applicant's specification provides the motivation for making the combination).

As described throughout the specification, one of the advantages/benefits (reduced crystal dislocations/defects in III-V semiconductors) of the present invention is derived by manufacturing a III-V nitrides alloy having a buffer layer formed by spin-coating so that the nitrides alloy film can be formed thereon in a manner than can reduce crystal dislocations/defects that are prevalent in these types of semiconductor devices. In contrast, the cited prior art suggests using only MOCVD for buffer layers in such III-V devices, whereas Agostinelli et al. and Ito et al. merely teach that spin-coating processes

are known individually. The cited prior art does NOT provide any suggestion to the **combination** of using spin-coating for buffer layers in III-V nitrides alloy.

Based on all the foregoing, it is submitted that claims 16 and 34 are patentable over the cited prior art. Accordingly, it is respectfully requested that the rejection of claims 16 and 34 under 35 U.S.C. § 103, be withdrawn.

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claims 16 and 34 are patentable for the reasons set forth above, it is respectfully submitted that all claims dependent thereon are also patentable. Further, it is submitted that the dependent claims are independently patentable by adding novel and non-obvious features to the combination.

## VI. CONCLUSION

Having fully and completely responded to the Office Action, Applicants submit that all of the claims are now in condition for allowance, an indication of which is respectfully solicited. If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.


To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this

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paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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**APPENDIX**

**IN THE SPECIFICATION**

The paragraph beginning on page 6, line 11 has been amended as follows:

--In an exemplary embodiment, the buffer layer 230 may be formed by spin coating a liquid which contains metal and oxygen. Then, the wafer is annealed in a gas atmosphere in which the gas [contatins] contains oxygen as an element.

**IN THE CLAIMS**

16. (Amended) An epitaxial growth method of III-V nitrides alloy, comprising:
- spreading liquid comprising group III elements and nitrogen on a substrate;
  - coating the substrate with a thin film comprising group III elements and nitrogen by spinning at [certain] selected rotation speeds; and
  - growing an III-V nitrides alloy film on the spin-coated film.
21. (Amended) The epitaxial growth method of claim 16 wherein the spin-coated film [after the annealing] is selected from the group consisting of GaN, AlN, InGaN, and AlGaN.
25. (Amended) The epitaxial growth method of claim [24] 16 wherein the epitaxial III-V nitrides alloy film is grown by a sequential combination of [more than] two or more growth methods selected from the group consisting of metal organic chemical vapor deposition, molecular beam epitaxy, and hydride vapor phase epitaxy.

26. (Amended) The epitaxial growth method of claim 16 wherein the [buffer layer] spin-coated film is formed by more than two spin coatings.

27. (Amended) The epitaxial growth method of claim 26 wherein the [buffer layer] spin-coated film is formed by more than two cycles of spin coating and annealing.

28. (Amended) The epitaxial growth method of claim 26 wherein the composition ratio varies in the [buffer layer] spin-coated film.

29. (Amended) The epitaxial growth method of claim 26 wherein the lattice constant in the [buffer layer] spin-coated film is monotonously increased from the substrate to the epitaxial III-V nitrides alloy film.

30. (Amended) The epitaxial growth method of claim 26 wherein the lattice constant in the [buffer layer] spin-coated film is monotonously decreased from the substrate to the epitaxial III-V nitrides alloy film.

32. (Amended) The epitaxial growth method of claim 31 wherein the [used] substrate is silicon covered by silicon carbide.

33. (Amended) The epitaxial growth method of claim 30 wherein the [used] substrate is silicon covered by zinc oxide.

34. (Amended) An epitaxial growth method of III-V nitrides alloy, comprising:

spreading liquid comprising group III elements and [nitrogen] oxygen on a substrate;

coating the substrate with a thin film comprising metal elements and oxygen by spinning at [certain] selected rotation speeds; and

growing an III-V nitrides alloy film on the spin-coated film.

39. (Amended) The epitaxial growth method of claim 34 wherein the spin-coated film [after the annealing] is selected from the group consisting of zinc oxide, magnesium oxide, and aluminum oxide.

43. (Amended) The epitaxial growth method of claim 34 wherein the epitaxial III-V nitrides alloy film is grown by a sequential combination of [more than] two or more growth methods selected from the group consisting of metal organic chemical vapor deposition, molecular beam epitaxy, and hydride vapor phase epitaxy.